Water-level Linkages between Lake Michigan/Huron Economic and Environmental Indicators

International Upper Great Lakes Study

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Presentation Outline

Context:

- IUGLS Study Objectives

Technical Analysis:

- Fundamental Approach
- Performance Indicators and Water Level Response Curves
- Coping Zone Concept
- Harbors and Marinas
- Ecosystems
- Regulation Plan Evaluation
- Summary

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Study Mandate – First Objective

Examine physical processes and possible ongoing changes in the St. Clair River and their impacts on levels of Lake Michigan-Huron and, if applicable, evaluate and recommend potential remedial options; and

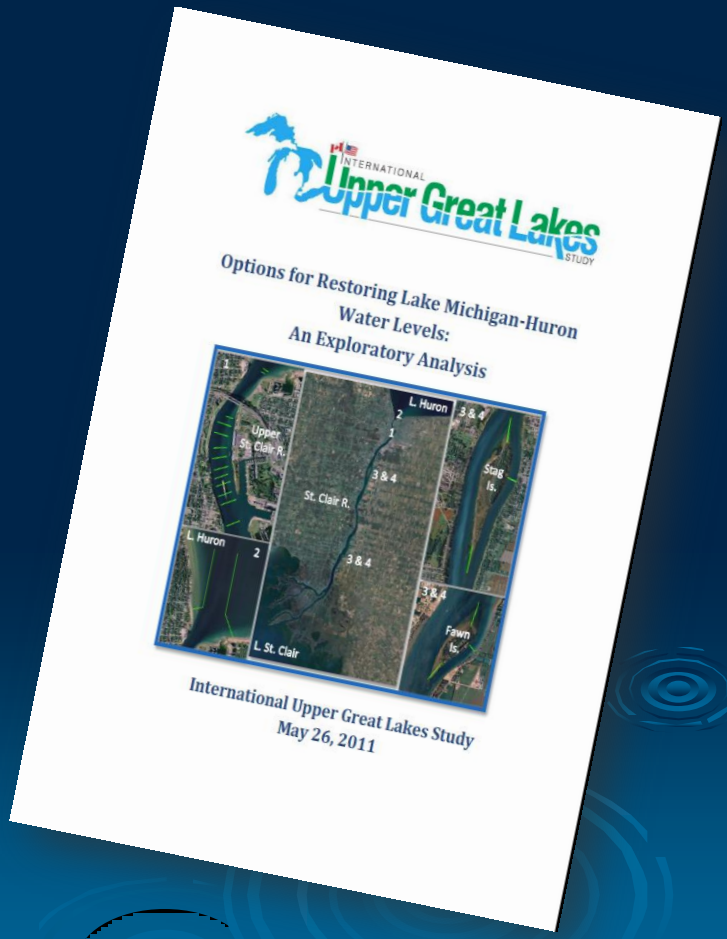
Study Mandate – Second Objective

Review the regulation of Lake Superior outflows and assess the need for changes to address the evolving needs of and conditions affecting the interests of the upper Great Lakes.

"Add-on" Restoration Analysis

- Restoration of Lake Michigan/Huron Water Levels by placing structures on the bed of the St. Clair River.
- The Study was not asked to make any recommendation on implementation.
- Analysis was exploratory.

Level	Rationale
0 cm	No change
10 cm	Post 1962 dredging
25 cm	Plus 27-ft channel (1959-1962)
40 cm	Plus 1930 mining & 25-ft channel
50 cm	All alterations since 1850



http://www.iugls.org/IndependentPeerReview.aspx

Fundamental Approach

- Understand the vulnerability of various sectors to water level regime changes in the Upper Great Lakes.
- Identify water-level ranges and threshold criteria that minimize adverse impacts to economic and ecosystem functions, i.e. water-level response curves, water level ranges, and threshold criteria.
- Compare proposed water-level regulation plans with water-level ranges and threshold criteria to assess potential economic and ecological responses.
- Provide guidance to the Plan Formulation and Evaluation Group and the IJC Study Board.

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Physical and Operational Limits at Sault Ste Marie

- Must not overtop the Compensating Works gates for dam safety
- Minimum and maximum upstream and downstream water levels to maintain hydro plant operations
- Minimum flows required to:
  - maintain rapids ecosystem,
  - provide water for ship locks and municipal/industrial uses,
  - keep hydropower plants operating (especially to avoid freezing in winter)

Performance Indicators and Water Level Response Curves

- Municipal, Industrial and Domestic Water Uses:
  - ✓ Inventory of water intakes and outfalls
- Commercial Navigation:
  - ✓ Transportation costs
- Hydropower :
  - ✓ Power generation & economic benefits
- Ecosystems:
  - ✓ Integrated Ecological Response Model based on data from selected Great Lakes sites
- Coastal Processes:
  - ✓ Erosion, flooding, low water and shore protection
- Recreational Boating:
  - ✓ Boat ramps and marinas

More than 70% of Recreational Boating Activity Related to Fishing

Economic Coping Zone Definitions

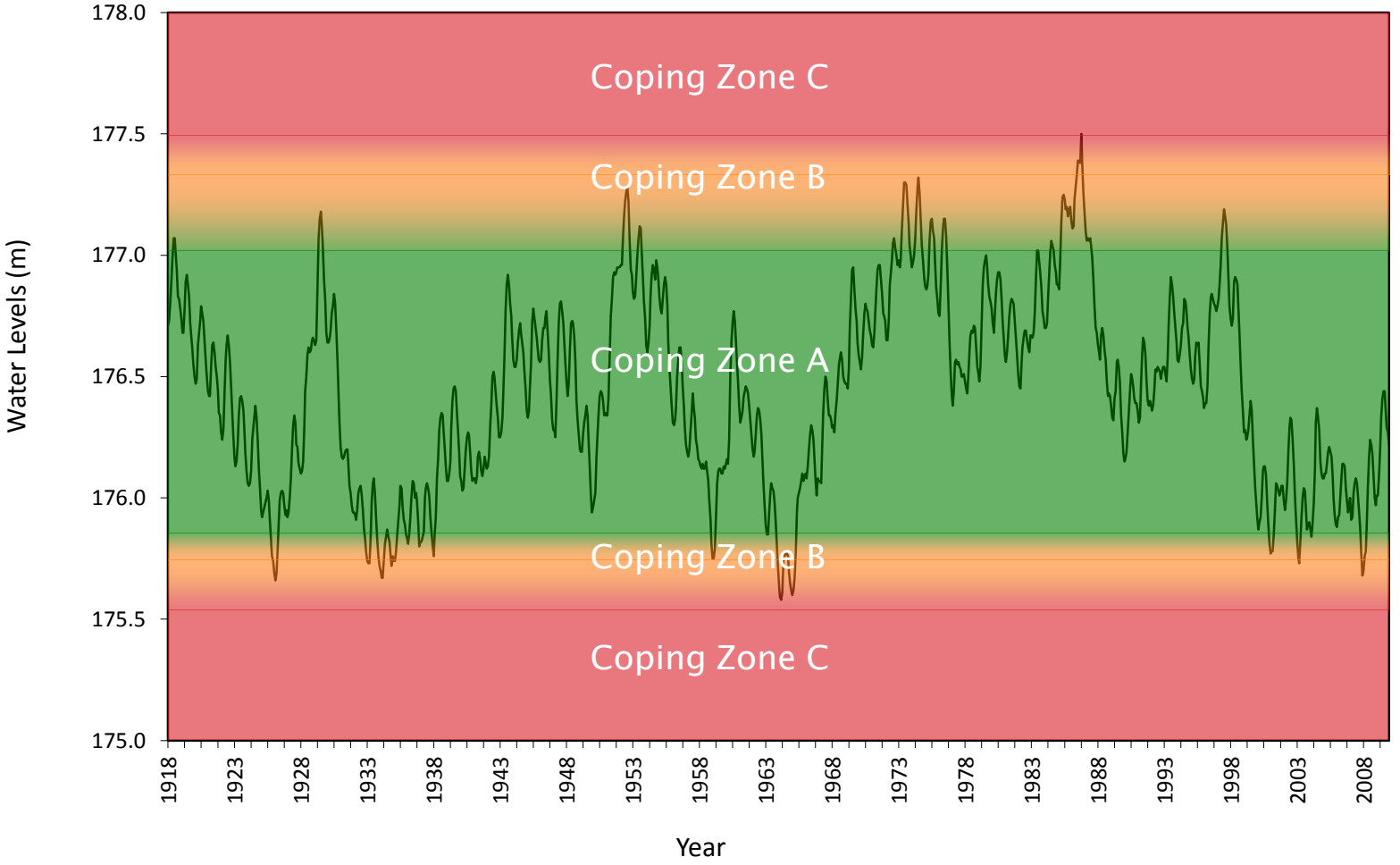
- Zone A – Water level regimes that are acceptable and within the tolerance and expectations of a sector. Acceptable levels may vary by sector and location, but are generally within the historical range and not at the extremes. Minimal economic impact.

- Zone B - Water level regimes at which stakeholders can cope under existing policies and infrastructure, but conditions are less than ideal. Stakeholders may suffer negative impacts and may incur additional costs to minimize impacts in this zone. Marginal conditions but generally survivable. Moderate economic impact – short to moderate term.

- Zone C - Water level regimes at which stakeholders can't cope using existing policies and infrastructure. Sustainability is threatened – for example: marinas to go out of business, commercial shipping is severely curtailed, coastal properties are destroyed, significant damage to infrastructure. Severe economic impact – long-term permanent loss.

Coping Zone Concept

Water Elevation and Duration



Recreational Boating Approach

- Determine water depths and GPS locations at more than 20,000 marina slips in 17 survey areas within Lake Erie, the St Clair river and lake system, Lake Huron including Georgian Bay, Lake Michigan, and Lake superior;
- Develop summary tables that reflect the distribution of slip depths by survey area. Interview marina owners/operators as to potential impacts of changing water levels.
- Identify water-level ranges and threshold criteria that determine when a slip or boat launch facility becomes unusable (or usable).
- Estimate cumulative economic impact (loss of revenue) when slips become unusable in response to changing water levels.

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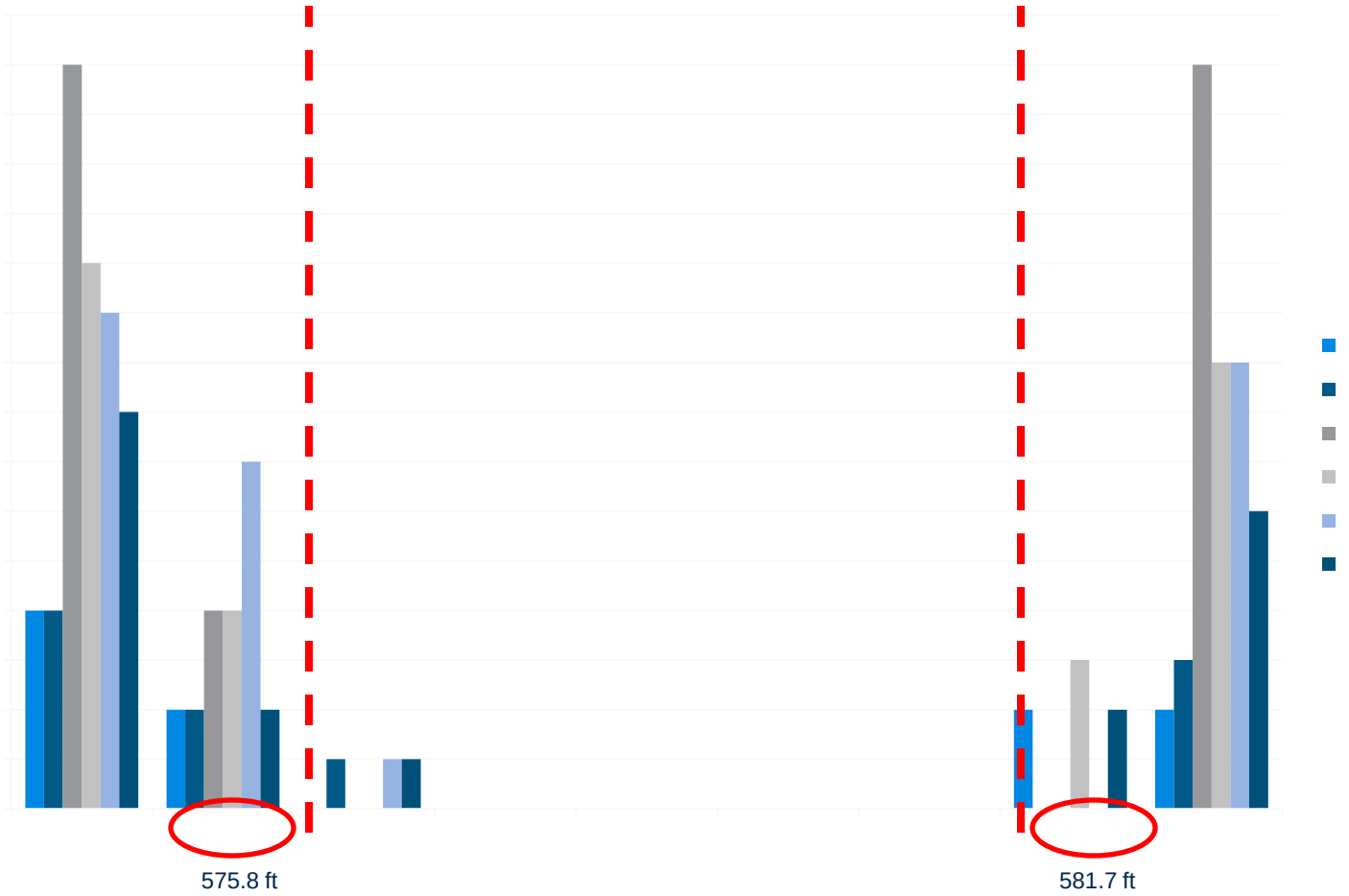
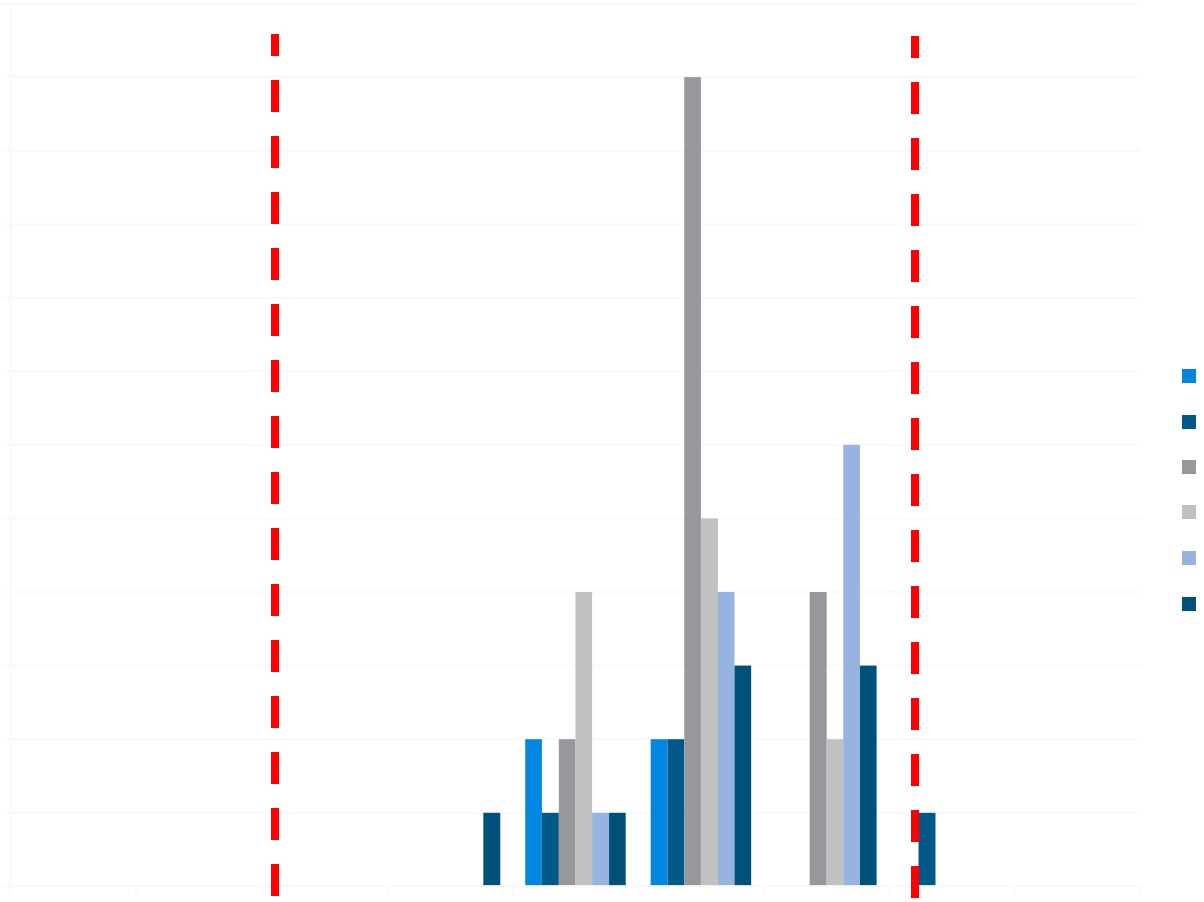


On Lake Huron, at least half of the marinas in the Little Current, Port Huron, and Goderich AOS would go out of business if the water level were to drop by three feet (0.9m) from the average elevation for May through August, 2009 (176.4m).



Georgian Bay region responses to water level drop scenarios (from interviews)

	Georgian Bay Region	One Foot Drop	Two Foot Drop	Three Foot Drop
	Average Water Level Elevation May thru August 2009: 176.4m	176.1m	175.8m	175.5m
	Response (Out of 26 Surveyed)			
Damages	Respondents Affected	10 of 26	19 of 26	25 of 26
	Launch Ramp Damage	3 of 26	4 of 26	5 of 26
	Dock Damage		4 of 26	6 of 26
	Seawall Damage		1 of 26	1 of 26
	Walkway Damage			1 of 26
	Fuel Dock Access Restricted			
	Increased Aquatic Weed Growth	1 of 26	1 of 26	1 of 26
	Reduced Demand for Winter Storage		1 of 26	1 of 26
	Sales Lost		1 of 26	1 of 26
Slip Loss	Marinas with >0% to 33% Slip Loss	4 of 26	10 of 26	11 of 26
	Marinas with 33% to 66% Slip Loss		2 of 26	2 of 26
	Marinas with >66% Slip Loss			4 of 26
Adaptations	Respondents who would Dredge	2 of 26	6 of 26	10 of 26
	Adapt with Floating Docks	1 of 26	1 of 26	1 of 26
	Adapt with Dock Modifications	2 of 26	2 of 26	2 of 26
	Adapt with Seawalls		1 of 26	1 of 26

Georgian Bay region responses to water level rise scenarios (from interviews)

	Georgian Bay Region	One Foot Rise	Two Foot Rise	Three Foot Rise
	Average Water Level Elevation May thru August 2009: 176.4m	176.7m	177.0m	177.3m
	Response (Out of 26 Surveyed)			
Damages	Respondents Affected	1 of 26	5 of 26	15 of 26
	Dock Damage		2 of 26	4 of 26
	Seawall Damage		1 of 26	3 of 26
	Walkway Damage			2 of 26
	Launch Ramp Damage			2 of 26
	Shoreline Erosion			
	Reduced Demand for Winter Storage			
	Flooding Related to Seiches			
Adaptations	Adapt with Dock Modifications	1 of 26	2 of 26	6 of 26
	Adapt by Rebuilding Facilities			1 of 26
	Adapt by Extending Docks			

Overall estimated annual economic loss from lost slips for three water level drop scenarios

Physical Estimate	1 Foot Drop	2 Foot Drop	3 Foot Drop	Interview Estimate	1 Foot Drop	2 Foot Drop	3 Foot Drop
Erie Region Total	**$461,220**	**$1,207,120**	**$2,242,140**		**$15,400**	**$231,680**	**$1,542,500**
Turkey Point	$268,400	$745,800	$1,336,500		$15,400	$196,900	$264,000
Kingsville	$164,400	$330,000	$652,800		$0	$24,000	$960,000
Port Colborne	$28,420	$131,320	$252,840		$0	$10,780	$318,500
South Huron Total	**$39,960**	**$189,840**	**$698,760**		**$179,520**	**$364,920**	**$706,080**
Port Huron	$34,200	$176,400	$606,600		$158,400	$315,000	$583,200
Goderich	$5,760	$13,440	$92,160		$21,120	$49,920	$122,880
Georgian Bay Total	**$224,100**	**$874,710**	**$1,911,510**		**$276,300**	**$830,160**	**$2,377,890**
Midland	$156,240	$652,860	$1,431,270		$75,330	$407,340	$1,701,900
Parry Sound	$67,860	$221,850	$480,240		$200,970	$422,820	$675,990
North Channel Total	**$11,620**	**$57,722**	**$148,792**		**$98,952**	**$204,064**	**$411,880**
Little Current	$7,168	$46,592	$110,208		$66,304	$120,960	$272,384
Richards Landing	$4,452	$11,130	$38,584		$32,648	$83,104	$139,496
Superior Total	**$812**	**$3,248**	**$11,368**		**$0**	**$0**	**$0**
Thunder Bay	$812	$3,248	$11,368		**$0**	**$0**	**$0**
Grand Total	**$737,712**	**$2,332,640**	**$5,012,570**		**$570,172**	**$1,630,824**	**$5,038,350**

Potential annual mitigation costs could be an order of magnitude greater

Ecosystem Planning Objectives

Manage water level regimes to support diverse biotic communities and natural ecosystem functions in the Upper Great Lakes.

Rationale:

- Biotic communities and the Great Lakes ecosystem have co-evolved and adapted to natural hydrologic regimes. By restoring natural water level and hydrologic regimes, native species and natural ecosystem functions will be enhanced and preserved.

Ecosystem Components and Performance Indicators

Component	PI Description	Scale
Landscape Features	Shoreline Type, Hardening, Nearshore Slope, Location	Regional
Hydrology	Magnitude, Frequency, Timing, Duration, Rate of Change	Regional
Wetland Vegetation	Change in Type, Area, Diversity, Invasives	Site Based
Fish	Change in Potential Spawning/Nursery Habitat (Nearshore/Riparian Connectivity), Sentinel species (Northern Pike, Sturgeon)	Site Based
Invertebrates	Change in Type, Diversity, Abundance	Site Based
Birds and Waterfowl	Change in Potential Nesting Habitat	Site Based
Species at Risk	Change in Type, Diversity, Abundance, Habitat	Site Based

Ecological Coping Zone Definitions

- Zone A - Natural variability with respect to water level / flow regime. "Natural" biotic community structure and ecosystem function.

- Zone B - Moderate changes to biotic community structure, but minimal changes to ecosystem function (can result from short-term natural variability)

- Zone C - Major changes to biotic community structure, and moderate to major changes in ecosystem function. Permanent long-term ecological change/degradation.

IERM2 Coping Zone Calculator

3. Zone “B” and “C” incidents tabulated for comparison across scenarios

1. Macro used to run the CZ evaluation for specified scenario

2. Coping Zone Criteria evaluated for each year (A, B, C)

IERM2 Coping Zone Analysis Worksheet

Plan ID:	77A
Worksheet:	77A HI

Evaluate

Zone "A":	106	104	109	109	109	109	0	104	109	106	108	109
Zone "B":	0	0	0	0	0	0	0	0	0	2	1	0
Zone "C":	3	5	0	0	0	0	0	5	0	1	0	0

Year	SUP-01	SUP-02	SUP-03	SUP-04	SUP-05	SUP-06	SUP-07	SMG-01	SMG-02	SMQ-01	SMQ-02	SMH-01
1900	A	A	A	A	A	A	n/a	A	A	A	A	A
1901	A	A	A	A	A	A	n/a	A	A	A	A	A
1902	A	A	A	A	A	A	n/a	A	A	A	A	A
1903	A	A	A	A	A	A	n/a	A	A	A	A	A
1904	A	A	A	A	A	A	n/a	A	A	A	A	A
1905	A	A	A	A	A	A	n/a	A	A	A	A	A
1906	A	A	A	A	A	A	n/a	A	A	A	A	A
1907	A	A	A	A	A	A	n/a	A	A	A	A	A
1908	A	A	A	A	A	A	n/a	A	A	A	A	A
1909	A	A	A	A	A	A	n/a	A	A	A	A	A
1910	A	A	A	A	A	A	n/a	A	A	A	A	A
1911	A	A	A	A	A	A	n/a	A	A	A	A	A
1912	A	A	A	A	A	A	n/a	A	A	A	A	A
1913	A	A	A	A	A	A	n/a	A	A	A	A	A
1914	A	A	A	A	A	A	n/a	A	A	A	A	A
1915	A	A	A	A	A	A	n/a	A	A	A	A	A
1916	C	C	A	A	A	A	n/a	C	A	A	A	A
1917	A	A	A	A	A	A	n/a	A	A	A	A	A
1918	A	A	A	A	A	A	n/a	A	A	A	A	A
1919	A	A	A	A	A	A	n/a	A	A	A	A	A
1920	A	A	A	A	A	A	n/a	A	A	A	A	A
1921	A	A	A	A	A	A	n/a	A	A	A	A	A
1922	A	A	A	A	A	A	n/a	A	A	A	A	A
1923	A	A	A	A	A	A	n/a	A	A	A	A	A

|Scenario Analysis ---> | Scenarios | IERM2 (77A HI) | IERM2 (PP HI) | Hyd Metrics (PP HI) | IERM2 (SupForMH HI) | Hyd Metrics (PP-S

Plan Evaluation is Ongoing

- Results from individual sector analyses are integrated with other sectors (navigation, hydropower, coastal, municipal and industrial water use, recreational boating, ecosystems…) in the Shared Vision Model (SVM). New plan will be very similar to current plan 1977A.
- Recreational Boating preference is for somewhat constrained water level ranges and generally higher than average water levels (facilitate access and minimize dredging).
- Ecosystems preference is to restore natural water level ranges and avoid fixed water levels (biodiversity enhancement)
- A new Lake Superior water-level regulation plan will have to address both of these needs as Recreational Boating and the Ecosystem are inextricably linked.

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Climate Change Impacts

- According to the most recent climate models, the climate in the upper Great Lakes basin during the next 30 years is likely to be characterized by:
  - an increase in precipitation and possibly more frequent intense storms (increased weather variability);
  - an offsetting increase in lake evaporation resulting from increased water temperatures and wind speeds, lack of winter ice; and,
  - slight increases in water supply to the basin during winter/spring accompanied by larger decreases in supply during late summer/early fall, resulting in slight overall annual declines.
- Results from the Study's two recently developed regional climate models predict that Net Basin Supply will remain near historic levels, whereas global climate models show much greater variability in Net Basin Supplies.

Summary

- The IUGLS Study has developed an non-traditional approach to assess potential environmental and ecological impacts (and benefits) resulting from changes in Lake Superior water level regulation. This approach is based on a sector-based vulnerability assessment that yields threshold criteria and coping zones for each of the sectors.

- Even though inextricably linked, Recreational Boating and the Great Lakes Ecosystem have considerably different threshold criteria and water-level regime requirements.

- Adaptive management will be incorporated into the new Lake Superior water-level regulation plan to address these different requirements and to respond to future potential changes in Net Basin Supply resulting from climate change.

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Acknowledgments

International Joint Commission
IUGLS Study Board
IUGLS Study Managers
ETWG Co-Chairs and Members
Rec Boating TWG Co-Chairs and Members
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